

June, 1944

1944
Circular 486



Control of European Corn Borer and Ear Smut on Sweet Corn with Dusts and Sprays

BAILEY B. PEPPER AND C. M. HAENSELER

New Jersey Agricultural Experiment Station
Rutgers University, New Brunswick, New Jersey

Life History and Habits of the Insect

Under New Jersey conditions the European corn borer normally completes two and sometimes a partial third generation. The winter is passed as full-grown larvae in burrows or feeding tunnels in the stem of the corn plant. During late April and all of May these larvae transform into pupae, the resting stage. From these pupae, adult moths emerge during late May and the month of June. In turn, the adult females lay their eggs during a period of about 20 or 30 days. The egg-hatching period begins about June 1 to June 5 in central New Jersey, somewhat earlier in the southern part of the state, and later in the northern part. Larvae developing from these eggs reach maturity and begin to pupate in early July. The pupae in turn produce moths which lay their eggs from late July to early September. Hatching of the second generation eggs begins about August 1 in central New Jersey and continues throughout August and part of September. The larvae from these eggs pass the winter in the corn plant.

The female moth lays her eggs in masses or clusters, usually on the underside of the leaves. The number of eggs in a mass varies from about 5 to 50, but is usually about 12 to 14. The eggs are pearly white and overlap somewhat, like fish scales.

Upon hatching, the young larvae soon disperse to places on the plants where they can find shelter and food. Those that hatch early in the season crawl between the closely rolled leaves of the whorl and begin to feed. As the larvae grow and the plants develop, the insects feed in the growing tassel, inside the stalk, and in the developing ears. Once the larvae bore into the stalk or ear they cannot be reached by insecticides.

When insecticides are used against the borer, they must be applied during the egg-hatching period so that the larvae will be poisoned before they become large enough to bore into the stalks or ears. The insecticide must also be directed to the part of the plant where the young larvae normally feed.

The hatching period of the second-generation eggs is longer than that of the first generation, and consequently more applications may be necessary against the second generation than against the first generation.

General Methods of Control

Although the use of chemicals in the form of sprays or dusts is the most effective means of controlling corn borer on sweet corn, other supplemental measures are helpful in reducing the borer population. Some of the more important of these are discussed briefly in the following sections.

Clean-Up Measures

Since the European corn borer passes the winter as full-grown larvae in their tunnels within the corn plant, many of these larvae can be destroyed by proper disposal of the crop remnants. To be effective, any farm or garden clean-up measure must be completed in the spring before the adult moths have emerged and should include all corn refuse within a large area. For best results in European corn borer control by clean-up measures, the operation must be on a community basis.

The following methods or combination of methods of destroying the overwintering borer are recommended:

- Feed cornstalks to livestock direct, as silage, or in finely shredded form.
- Plow under all crop remnants deeply and cleanly before late April when the borers begin to pupate. The stalks of early-maturing sweet corn containing borers should be plowed under or otherwise disposed of as soon as the ears are harvested. If plowing is to be effective, no debris of any kind should be left on top of the soil or brought to the surface by future operations.
- Rake and burn completely all infested crop remnants.

Crop Rotation

Crop rotation may be used to good advantage in controlling corn borers. The practice of following corn with an early crop the next spring often aids in getting infested crop remnants plowed under before the borers pupate or adults emerge.

Date of Planting

It is possible to regulate the time of planting sweet corn so as to bring the harvest period between the two broods of borers and thereby reduce the losses from borer injury. Sweet corn that matures from about July 25 to August 20 in the central part of the state usually contains very few borers and suffers little damage, whereas corn that matures before or after these dates may be severely injured. These dates vary somewhat according to the season and to the location in the state. In the southern part, the dates will be earlier, and in the northern part, somewhat later. The time of planting would, of course, depend on the variety of sweet corn used.

Varieties of Sweet Corn

Sweet corn varieties differ greatly in their susceptibility to corn borer infestations. It is apparent that the early planted, fast-growing, short-season varieties are more heavily infested and more severely damaged than midseason

Dusts

Although sprays are cheaper to use and have been slightly more effective under some conditions than dusts for the control of the corn borer, the dusts have proved satisfactory under New Jersey conditions. The following three dust formulas have given good results:

Formula 1—Rotenone Dust (1%)

Finely ground derris or cube root (containing 5% of rotenone).....	20 lbs.
Dusting sulfur	25 lbs.
Wetting agent (see footnote, p. 7)	2 ozs.
Talc or clay	55 lbs.

Formula 2—Fixed Nicotine Dust (4%)

Nicotine-bentonite concentrate (containing 14% of nicotine).....	28 lbs.
Dusting sulfur	25 lbs.
Walnut shell flour or talc.....	47 lbs.
Wetting agent (see footnote, p. 7)	2 ozs.

Formula 3—Rotenone-Fixed Nicotine Dust (½% rotenone and 2% nicotine)

Finely ground derris or cube root (containing 5% of rotenone).....	10 lbs.
Nicotine-bentonite concentrate (containing 14% of nicotine).....	14 lbs.
Dusting sulfur	25 lbs.
Wetting agent (see footnote, p. 7)	2 ozs.
Talc or clay	51 lbs.

When rotenone and nicotine are used in the same formula, sulfur must be added to prevent the nicotine from destroying the rotenone. In formulas 1 and 2, however, the 25 pounds of sulfur may be omitted and an equal quantity of the inert carrier (talc, walnut shell flour, or clay) added, but smut control appears to be better when the sulfur is added.

Unless adequate dust-mixing equipment is available; it might be wise to purchase the ready-mixed dust or have a local mixing firm mix the dust according to the above specifications.

When and Where to Apply Insecticides

The first application of insecticide should be made when the first egg masses in the field begin to hatch. This time varies from year to year and from locality to locality. Therefore, the insecticide application must be timed for the field to be treated. The size or the growth stage of the plant does not necessarily have a bearing on the beginning of the treatment schedule. Normally, few eggs are laid on plants less than 12 inches tall.

Since egg-laying and hatching continue 3 weeks to a month for the first generation and 6 weeks or longer for the second generation, the first application should be followed by three additional applications made at 5-day intervals on first-generation borers and by at least four additional applications at 5-day

intervals on the second generation. These frequent applications are necessary because during a 5-day period the residue of the insecticide becomes diluted by weathering, and unprotected surfaces become exposed through rapid growth of the plant.

Unlike many other insects, the European corn borer larvae feed in certain restricted areas on the corn plant. The insecticide, therefore, need not cover the entire plant surface, but it should be directed to the areas where the young larvae are feeding. Under average conditions the first application on early-planted corn will come when the plant is in the pretassel stage or when the tassel begins to show deep in the funnel-shaped whorl. At this stage the insecticide should be directed at the open whorl, covering the spaces between the overlapping leaves with a deposit of the chemical. When the ear shoots begin to form, they as well as the opening tassels should receive the insecticide. After the tassels are fully open they become unpalatable to the borers, and, therefore, it is unnecessary to continue dusting them.

How to Apply Insecticides

Enough insecticide should be applied to penetrate all of the places where borers feed.

When power dusters are used, at least two nozzles per row should be adjusted so as to direct the dust downward into the whorl or into the opening tassel or at the developing ear. These nozzles should form a band of dust no wider than is necessary to cover the vital areas with the insecticide.

With hand dusters the operator should travel slowly enough to permit a thorough application of dust to the areas where the borers feed.

Sprays should be applied to the same areas as described for dust. With power sprayers three nozzles per row should be used. One nozzle, over the row, should discharge the spray downward. The other two nozzles, one on each side of the row, should be 6 to 12 inches below the center nozzle and directed inward and downward, directing the spray to the ears, tassels, or open whorl.

Efficient, high-clearance, power spraying equipment for sweet corn has been developed by the U. S. Bureau of Agricultural Chemistry and Engineering.

Power sprayers ordinarily used on row crops should be satisfactory for the first and second applications, after which dusting equipment may be used.

Quantity of Insecticides Necessary

Under average conditions, about 35 pounds of dust or 100 to 125 gallons of spray per acre per application is a desirable dosage.

The rate of application of sprays and dusts necessary to give adequate coverage varies according to the size of the corn; early applications while the corn is small should require less than late applications or when the corn is in tassel.

The density of the borer population should be a guiding factor. If the infestation is severe the rate of application should be heavier than if the infestation is light.

CORN SMUT

In New Jersey, smut (*Ustilago zeae*) is the most destructive disease on sweet corn, and on some of the early varieties it is often a major factor in determining profits and losses. Losses of 5 per cent of a sweet corn crop due to ear smut may be expected in almost every field, and losses of 10 to 15 per cent are very common. On some of the highly smut-susceptible hybrids, 20 to 30, and occasionally more than 60 per cent of the ears are destroyed by the smut fungus.

Life Habit of the Fungus

The smut fungus is particularly well adapted to a perennial existence in our more important sweet corn growing areas. When the corn is harvested for the green corn market, nearly all of the large black smut boils or masses of smut spores that develop on the infected ears are left in the field to be disced or plowed into the soil. Thus the soil becomes contaminated with immense numbers of smut spores, which may lie dormant for a year or more, until corn is planted in the field again. The smut spores may also be blown with dust particles from contaminated fields to others some distance away, and as a result smut may occur in the field that has not grown corn in recent years and that is far removed from other corn fields.

If smut spores are abundant and the weather conditions are favorable for germination of the spores when the developing ears are most susceptible to infection, and if the variety is highly susceptible to the disease, a large percentage of the ears may become infected. Under other circumstances little smut may develop. Thus the disease may vary in severity from year to year, sometimes causing little trouble, sometimes much.

General Control Measures Not Satisfactory

No very satisfactory control measures have been available for smut on sweet corn. A few practices such as careful field sanitation, crop rotation, use of resistant varieties, and proper choice of maturity date have, however, given partial control in certain cases.

Field sanitation, such as removing and destroying all smut boils before they break and avoiding the use of manures that contain smut spores, may be helpful in small isolated fields and home gardens, but such measures are rarely practical in commercial sweet corn areas where spores are so easily blown from field to field. To be effective, sanitation would have to be practiced over a wide area, possibly on a community basis.

Rotation in which corn is grown only once every 4 or 5 years will also reduce the number of available smut spores, but here also the benefits may be largely lost if contaminated manures are used or if smut spores are blown in from nearby infested fields.

Some varieties of sweet corn are less susceptible to smut than others. Those with a very tight husk and a long husk tip, for example, are said to be less subject to ear smut losses than the loose-husked, short-tipped varieties. The use of such smut-resistant varieties is obviously the simplest method of smut control, and in every case where a desirable resistant variety is available this method should be used. Unfortunately, most of the highly resistant varieties now available mature late or lack quality. Most of the early, high-quality varieties, on the other hand, appear to be highly smut-susceptible under New Jersey conditions. Since the early-maturing varieties are preferred in our more important sweet corn areas, the use of disease-resistant varieties cannot solve the smut problem until new smut-resistant, early, high-quality varieties have been developed through breeding.

Because of the marked influence of the weather, the same variety of sweet corn planted at weekly intervals in the same field may show wide differences in the amount of ear smut developing on the various plantings. Early-planted sweet corn frequently develops more smut than later seedings of the same varieties, but this does not always hold true. New Jersey weather is so variable that it is impossible to predict which planting will reach the most susceptible stage for ear infection during a period favorable for development of the disease. Consequently, little is gained by trying to escape the smut by out-guessing the weather.

The growth rate or vigor of the corn plant as influenced by soil, climatic, and nutritional conditions likewise affects the ease with which smut infection occurs. But here also there is little hope of effecting a practical control of the disease by cultural methods, because the well-fed, rapidly growing plant, which offers the best prospects for a good yield, is most subject to the disease.

It is obvious that some direct method of smut control is needed until corn breeders can effect a permanent solution through development of suitable resistant varieties. The dust and spray method described here should aid materially in meeting this need.

Smut Control by Dusts and Sprays

In 1940 the senior author observed that sweet corn smut was much less prevalent in experimental plots which had been sprayed and dusted for the control of European corn borer than in untreated plots. These observations have since been verified by many tests. Thus it has been found possible, through the use of protectant sprays and dusts to control both European corn borer and ear smut in the same operation.

Materials

Marked reduction in ear smut has been obtained from the use of dusts containing either rotenone or nicotine as the active agents, and each of the special borer control formulas mentioned on page 8 has given effective control of smut. Most of the smut control tests have been conducted with a dust made according to formula 1.

Method of Application

The same method and rate of application and the same time schedule recommended for borer control (p. 8) have proved very satisfactory for ear smut control. Further study may show that a simpler program is effective in smut control, but for New Jersey growers it would be advisable to adhere to a program that will control both borer and smut.

In most of the experiments the dust was applied at 5-day intervals, starting about 10 days before the first silks appeared and ending about 5 to 7 days after silking started. This schedule, which is the same as that advocated for borer control, might appear to be very early for the prevention of ear smut, which rarely becomes conspicuous until the ears are well formed. Timing experiments have indicated, however, that dust applications made before the silks appear are far more effective in preventing ear infection than are applications made after the silks emerge.

The smut control dust may be applied either by power or by hand dusters. Both gave equally good results when the dust was directed downward into the top whorl of the young plant so that the dust settled on the tops of the leaves near the stalk and into the leaf sheaths of the older leaves.

The degree of smut control obtained seems to depend somewhat on the severity of the disease. In the many tests conducted during the last 4 years, the control obtained was never less than 33 per cent, and most of the treated plots had only 20 to 50 per cent as many smut-infected ears as the untreated

TABLE 1

Control of Ear Smut on Sweet Corn with Dusts and Sprays in Various Experiments Conducted in 1940-1943

Test No.	Year	Sweet Corn Variety	Location of Test	Active Ingredient R (otenone) N (icotine) M (iscellaneous)	Method of Application H (and) P (ower) D (uster) S (prayer)	Number of Smut-Infected Ears ¹ on 100 Stalks		Per Cent Control
						Untreated	Treated	
1	1940	Earlgold	Englishtown	R	HD	24.00	1.00	96
2	1940	Earlgold	Englishtown	N ²	HD	24.00	3.00	87
3	1940	Earlgold	Englishtown	R ³	HS	24.00	1.50	94
4	1940	Earlgold	Englishtown	N	HS	24.00	6.00	75
5	1940	Golden Cross Bantam	Englishtown	M ⁴	HS & D	6.00	0.11	98
6	1941	Marcross 13.6	New Brunswick	R	HD	20.40	13.60	33
7	1941	Marcross 13.6	New Brunswick	R	HD	41.20	26.80	35
8	1941	Marcross 13.6	New Brunswick	R	HD	41.40	17.80	57
9	1941	Marcross 13.6	New Brunswick	R	HS	41.40	15.20	63
10	1941	Marcross 13.6	Englishtown	M ⁴	HS & D	2.10	0.10	95
11	1942	Carmelcross	Moorestown	R	PD	16.08	3.25	80
12	1942	Gold Medal	Moorestown	R	PD	12.41	2.69	78
13	1942	Whipcross	Moorestown	R	PD	16.80	6.68	61
14	1942	Earlgold	Beverly	R	PD	13.98	3.15	77
15	1942	Carmelcross	Beverly	R	PD	12.48	4.03	68
16	1942	Marcross 39	Caldwell	R	HD	1.67	0	100
17	1942	Marcross 13.6	Englishtown	R	PD	6.18	0.61	91
18	1942	Marcross 13.6	Englishtown	N	PD	4.07	1.02	75
19	1942	Marcross 13.6	Englishtown	M ⁴	HD	12.00	0.11	99
20	1942	Marcross 13.6	New Brunswick	R	HD	18.54	10.10	46
21	1942	Ioana	Milltown	M ⁴	HD	9.00	0.29	97
22	1943	Marcross 13.6	New Brunswick	R	HD	39.60	21.40	46
23	1943	Marcross 13.6	Englishtown	R ³	HD	36.50	9.00	76
24	1943	Marcross 13.6	Englishtown	R+N	HD	36.50	3.00	92
25	1943	Marcross 13.6	Englishtown	N ⁵	HD	36.50	5.60	85
26	1943	Lincoln	Milltown	R ³	HD	10.00	0	100
27	1943	Lincoln	Milltown	N	HD	10.00	0	100

¹ Smut records taken on two ears or potential ear shoots per stalk; thus the percentage of smut-infected ears would be one-half the figures given.² Average from two plots treated with different nicotine formulas.³ Average from two plots treated with different rotenone formulas.⁴ Composite data from plots treated with several different rotenone and nicotine formulas.⁵ Average for five plots treated with different nicotine formulas.

